



OpenAIR@RGU

The Open Access Institutional Repository at Robert Gordon University

<http://openair.rgu.ac.uk>

This is an author produced version of a paper published in

Fat matters: from sociology to science (ISBN 9781905539390)

This version may not include final proof corrections and does not include published layout or pagination.

Citation Details

Citation for the version of the work held in 'OpenAIR@RGU':

BROOM, I. and ROLLAND, C., 2010. Homo Adipatus – a new species: weight management, treatment and prevention. Available from <i>OpenAIR@RGU</i>. [online]. Available from: http://openair.rgu.ac.uk
--

Citation for the publisher's version:

BROOM, I. and ROLLAND, C., 2010. Homo Adipatus – a new species: weight management, treatment and prevention. In: G. TSICHLIA and A. M. JOHNSTONE, eds. Fat matters: from sociology to science. Keswick: M&K Update Ltd. Pp. 51-66.

Copyright

Items in 'OpenAIR@RGU', Robert Gordon University Open Access Institutional Repository, are protected by copyright and intellectual property law. If you believe that any material held in 'OpenAIR@RGU' infringes copyright, please contact openair-help@rgu.ac.uk with details. The item will be removed from the repository while the claim is investigated.

[CH]Chapter 5

Homo Adipatus – A New Species: Weight Management, Treatment and Prevention

Iain Broom and Catherine Rolland

The current obesity epidemic, indeed pandemic, is a major public health problem affecting not only the developed nations but also developing countries as they become modern industrialised nations. Over the last thirty years the prevalence of obesity has increased from 6-8 per cent to almost 25 per cent in the UK [1]. There have always been obese individuals within populations over the centuries and indeed in the nineteenth century in the UK, increasing abdominal girth was seen as a sign of affluence and certainly not frowned upon. Obesity is still seen as such in developing countries.

The earliest depiction of the obese phenotype is from stone-age sculptures. The existence of such sculptures clearly demonstrates both the social importance attached to such a phenotype and the survival advantage conferred in accumulating large fat stores. The ‘Venus of Willendorf’ is the most famous of these (http://en.wikipedia.org/wiki/venus_of_Willendorf) whose abundance of body fat is suggested to have been diet related (high fat) in association with a sedentary lifestyle of cave-confinement during the glacial era.

This is not too far distant from our current dietary consumption of convenience high fat, high sugar meals in association with our computer/software driven lifestyle. One might suggest that by looking at the changing body shape over the last half century, Homo sapiens has evolved into Homo Adipatus (Figure 5.1) and a new species has

been created. Species development however depends on genetic change and takes hundreds if not thousands of years. The obese phenotype has evolved over the last fifty years and now accounts for approximately 25 per cent of the UK population and 30 per cent of the population of the USA.

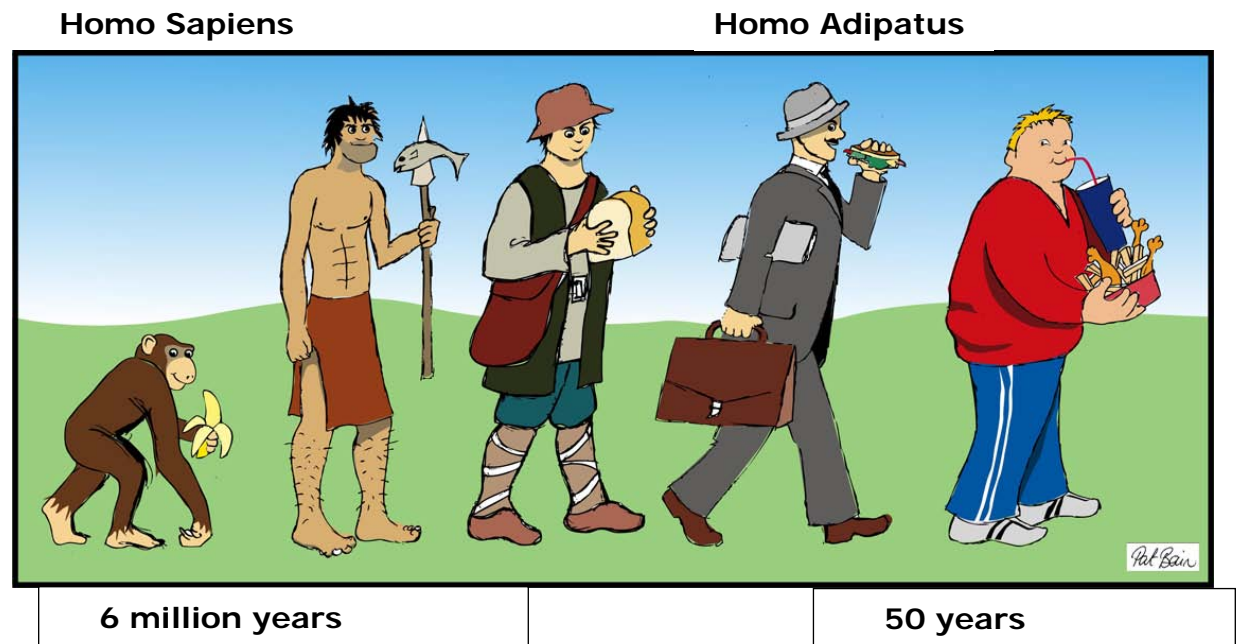


Figure 5.1 Homo Adipatus: a new species?

The dangers in the rising weight of the nation relate to the impact of obesity on health. Obesity impacts extensively on both morbidity and mortality statistics. Although in earlier times obesity was seen to have a survival advantage during periods of famine, it was also recognised as early as 400 BC by Hippocrates to have concomitant health hazards: ‘Sudden death is more common in those who are naturally fat than in the lean’; ‘Corpulence is not only a disease in its own right but a harbinger of others’ (Hippocrates 400 BC).

Today obesity is seen as the major aetiological factor in the development of Type 2 Diabetes Mellitus and is second only to smoking as the primary cause of cancer. Obesity is an independent risk for cardiovascular disease and is associated with the development of hypertension and dyslipidaemia thus adversely influencing cardiometabolic risk. In addition obesity is linked to musculo-skeletal pathology, mental health problems and increased risk of inflammatory/infectious disease.

[A] Aetiology of Obesity

Although there is a clear genetic tendency for obesity to occur in families this in no way explains the current explosion of obesity seen across the world in the last half century. It is thought, however, that 40 per cent of the causation of obesity can be attributed to genetics. There are a number of single gene defects that can give rise to the obese phenotype, e.g. leptin deficiency, MC-4 receptor defects and Laurence, Moon-Biedle syndrome. The number of patients with such problems are very few and single gene defects do not contribute to the current pandemic. Obesity tends to be a polygenic disorder in origin and the obese phenotype is closely linked to environmental interactions with our genetic inheritance. There are numerous factors involved in the evolution of the obese phenotype and these are outlined in Figure 5.2.

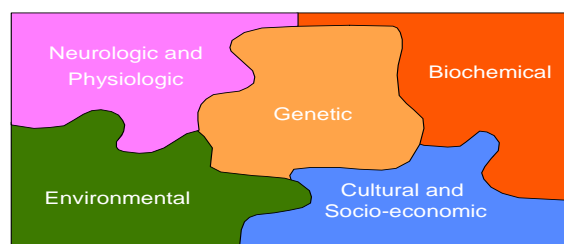


Figure 5.2 Factors involved in the creation of Homo Adipatus [2]

The factors influencing the development of the obese phenotype that have changed are a) environmental and b) cultural and socio-economic. It is the rapid change in these two areas that has impacted on our genetic inheritance to produce the obesity epidemic. Indeed obesity is probably the best example of a disease produced by altered gene-environment interactions. We have an inherited gene pool, moulded by famine over the millennia, that is ill-equipped to handle the current toxic obesogenic/diabetogenic environment. The environmental and cultural/socio-economic changes that have occurred in the last fifty years are huge, and Homo sapiens has not been able to adapt to such changes to allow energy homeostasis. Both the macro- and micro-environments of population and family have seen tremendous changes over this time period. Society operates completely differently in 2007 than in 1957. There have been major changes in demographics, alterations in transport, major increases in automation and differences in the way society perceives risk. All of these impact adversely on energy expenditure. Energy intake has also altered dramatically both in the nature of the food eaten but also in the mode of preparation and delivery. The impact of these changes is to affect a net positive energy balance in the individual with consequent deposition of fat and increasing weight.

Table 5.1 outlines the changes in adult energy expenditure in daily living between the 1950s and 2000s.

Table I: Calorie Usage Changes Over 50 Years

Per week	1900s		2000s	
Shopping	On foot	2400	By car & supermarket	275
Washing clothes	By hand	1500	Washing machine	270
Making a coal fire		1300	Lighting a gas fire	3
Per hour	1990s		2000s	
Lawn mower	Manual	500	Electric mower	180
No power steering		96	With power steering	75

Table 5.1 Calorie usage changes over 50 years

In 1980 there were 5000 food items on supermarket shelves whereas in 2000 there were 35000 food items. The increase in numbers relates, in the main, to pre-prepared and fast foods often energy dense and appetite stimulating. Meals taken out of the home and snacking have increased dramatically over the years. All of these factors lead to a tendency to increased energy intake. Even the way food is eaten at home has changed or rather the environment in which food is eaten has changed. No longer do families tend to sit round the table as a group to eat and to have social intercourse. This in its own right leads to increased rate of eating and hence increased consumption but also tends to reduce energy expenditure on a daily basis by reducing small hand and face movements occurring during conversation. Societal changes in the shape of the 'free market economy', developed effectively in the 1980s, also impact on the level of obesity.

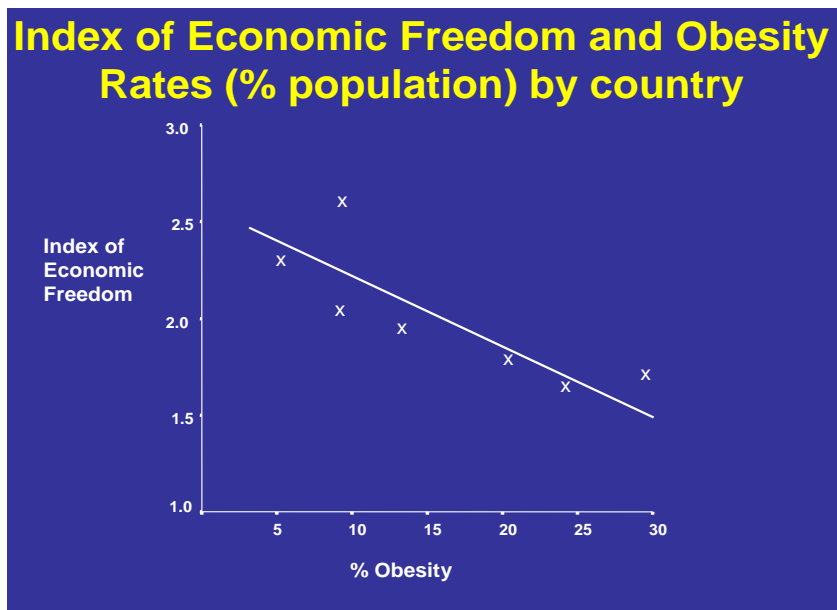


Figure 5.4: Effects of free-market economy on national obesity rates

Figure 5.4 Effects of free-market economy on national obesity rates (Scottish Executive, 2006 – see reference at end of document)

The countries, such as the USA, UK and Australia, which have freed up their economies most, have the worst obesity prevalence rates. Other countries with some degree of economic protection, e.g. Scandinavia, France and Holland have not seen acceleration in their obesity prevalence rates in the same way. These external effects impact on a control mechanism for energy homeostasis that is molecular in nature and designed to cope with frequent episodes of famine and not with our current developed world's plenty.

[A]Control of Energy Metabolism

The human body is designed to put weight on in periods of plentiful supply of food and to use these fat stores in periods of famine. Control mechanisms have evolved to allow survival of the species and hence to limit weight loss. Such processes are

molecular in origin and involve cross-talk between the brain and the gut, and the brain and adipose tissue. These molecular mechanisms are extremely complex and are only just beginning to be unravelled. As the focus of these mechanisms is on preventing weight loss, it explains in part why achieving and maintaining weight loss in the overweight and obese is so difficult. The hypothalamus in the brain is the area organising the control of energy metabolism. This area could effectively be termed the body's thermostat. This area receives and transmits messages from both the gut and adipose tissue and is responsible for responding in particular to energy deficits. A large number of protein molecules are involved in these mechanisms, both as receptors within the hypothalamus but also proteins/peptides derived from both gut and adipose tissue. In brief, appetite signals and the need to eat to maintain body weight tend to derive from adipose tissue stores, whereas satiety signals are more relevant to gut-brain cross-talk. The relationships between these molecules and their complex cross-talk cannot be dealt with here in detail.

The major nutrients themselves have an effect on both appetite and satiety as does the rate of food intake. Protein is the most satiating of the macronutrients, followed by carbohydrate whereas fat in the diet has little effect on satiety or appetite. Hence a diet high in fat is likely to cause both increased food and energy intake.

(Discussions with respect to changing macronutrient content of the diet will be dealt with below in the treatment section.)

During periods of weight loss the hypothalamus swings into action to try and reduce the rate of weight loss by various mechanisms:

- 1) Switches from carbohydrate to fat as main energy source

- 2) Reduces the need to break down lean body mass to provide carbohydrate precursors for energy transduction
- 3) Reduces resting energy expenditure
- 4) Maintains 'thermostat' setting at the original body weight and correlates weight to adipose tissue stores.
- 5) The overall effect is to limit weight loss and drive weight gain. Thus, during periods of weight loss, the hypothalamus is striving, by molecular means, to drive weight regain. Indeed even if weight loss ceases, this part of the brain will continue to drive weight upwards unless weight is maintained at the new reduced level for some considerable period of time (Figure 5.5).

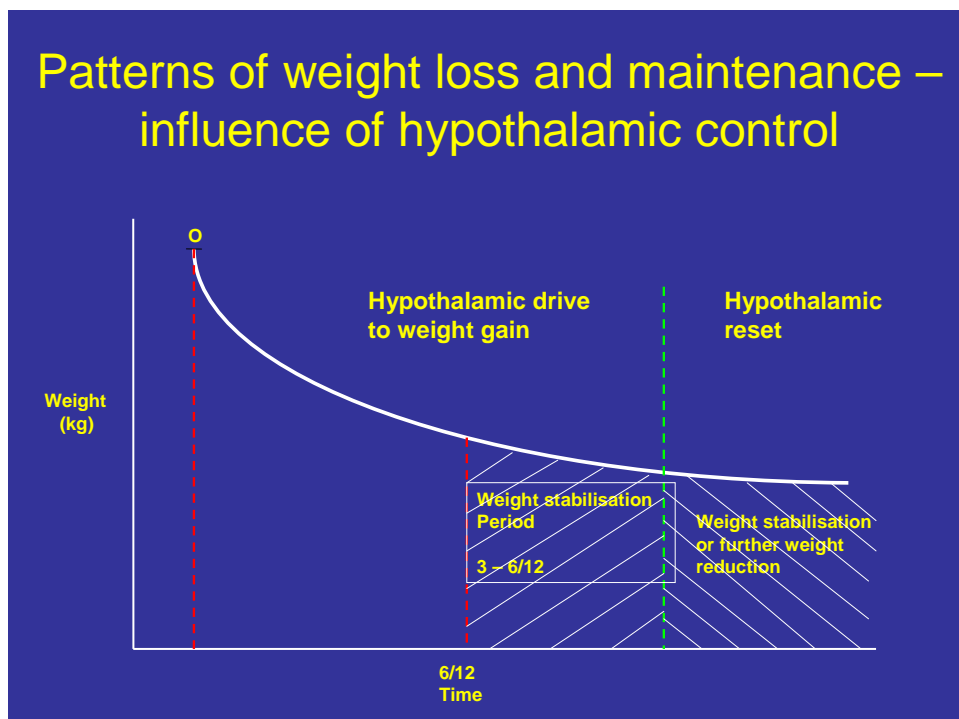
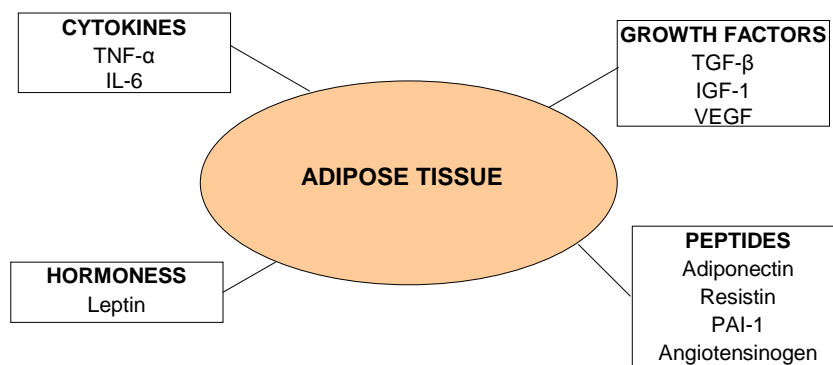


Figure 5.5 Weight loss and maintenance including the influence of hypothalamic control.

Unless the reduced weight loss is maintained constant for some time the hypothalamus (thermostat) will not reset at the new lower level, and the tendency is for weight regain and indeed overshoot with eventual weight gain from baseline

weight. This to some extent explains the natural history of obesity, i.e. to gain weight of approximately 1 to 2 Kg per year despite intervening weight loss. It is now realised that adipose tissue is not just a storage depot for fat but is an endocrine organ in its own right producing signal molecules for controlling not only energy metabolism but also immune functions, reproductive activity and if allowed to accumulate in ectopic areas will increase risk of cardiometabolic disease. If accumulation of fat is increased, especially in ectopic areas, this produces a pro-inflammatory state leading to exacerbation in inflammatory disease such as asthma and the arthritides but also, by altering the redox potential of cells, fat accumulation has a pro-carcinogenic effect leading to increased risk of neoplasia. Obesity, after cigarette smoking, is the second commonest cause of cancer. Some of the protein signals produced by adipose tissue are outlined in Figure 5.6.

Figure 5.6 Adipose tissue as an endocrine organ




It is important to note that ectopic fat such as viscera-associated fat tends to produce more metabolically disadvantageous molecules, e.g. pro-inflammatory mediators. In

addition such ectopic fat deposition tends to lead to reduction in adiponectin secretion resulting in increased insulin resistance and increased CVD risk. Increased adipose tissue stores also tend to alter levels of sex steroid metabolism leading to both fertility problems in females and males and increased risk of ovarian/breast/uterine cancer in females and prostate cancer in males. Overall the complexity and understanding of control mechanisms in the obese state remain far from clear and further research in this area remains a major focus. This is also a clear focus for future drug treatment in this area with all major pharmaceutical firms supporting extensive research on energy regulation. This does not imply that drug treatment will be a panacea to deal with the current obesity pandemic, but it may aid in its control.

[A]Treatment Strategies

Since the main focus of metabolic control is to prevent weight loss, treatment strategies for obesity management have proved extremely difficult for successive governments both in the UK and elsewhere. The strategies currently in vogue are outlined in Table 5.2.

Table 5.2 Treatment strategies for the management of overweight and obesity

Table 5.2: Treatment Strategies for the Management of Overweight and Obesity	
A. Governmental	
1. Lifestyle Modification <ul style="list-style-type: none">• Dietary interventions• Increased activity• Decreased inactivity• Behaviour modification• Stress management	 Population and Individual
2. Drug Therapy	
3. Surgical Intervention	
4. Public Health/Health Promotion (to date ineffective)	

B. Non-Governmental
Patient driven interventions with no evidence base
<ul style="list-style-type: none"> • Herbal remedies • FAD diets

Lifestyle alteration remains the main focus of attention in managing the obesity epidemic. This effectively concentrates on three areas of intervention with all the evidence suggesting that a combined approach using all three aspects is most effective. These include: dietary manipulation, increased activity/decreased inactivity and behaviour modification. It is clear from the literature that a combination of these approaches produces the best results in both the short and long term [3]. Education however of both patients and healthcare workers remains the prerequisite for successful management, as highlighted in the Counterweight Programme [4,5,6,7]. It is important to differentiate between population strategies and individual treatment programmes for the successful management of obesity, especially in the areas of diet and behaviour change, less so in the advocacy of increased activity. In relation to activity levels, it is essential that the population as a whole is encouraged to increase their activity levels and oppose their sedentary lifestyle encouraged by the ongoing environmental changes linked to automation and the sociopathic computer era. Individual increases in activity levels relating to reducing the obese state may have to be more tailored to specific individuals. It is not clear what particular form of increased activity is suited to a particular patient. Individual preferences may have to be taken into consideration. The countryside, open spaces and walking are free to all and reliance on ‘exercise on prescription’ is not the panacea. Motivational interviewing in this area, encouraging outdoor activities such as simple walking will

be much more effective and have no cost implications to the patient or government, local or national.

Dietary manipulation remains the mainstay of all obesity management programmes. As a population the focus on reducing fats and sugar in the diet is appropriate and should be maintained. There is considerable evidence in support of high fat, relatively low-carbohydrate (but high sugar), low fibre diets of Western societies being a major aetiological factor in susceptible individuals. Excess dietary fat is more easily converted to adipose tissue lipid stores than carbohydrate (Flatt, 1985); diet-induced thermogenesis is less with fat than carbohydrates or protein thus inducing lower metabolic rates with high fat diets (Lean and James, 1988; Lean *et al.*, 1989); and dietary fat has minimal effects on both appetite and satiety (Caterson and Broom, 2001). Further education of both patients and healthcare staff in this area remains a priority [8]. Fast food outlets, although tending to change their attitudes, remain a major barrier in this area, especially in relation to portion size. Thus high fat diets lead to increased overall food consumption with marked energy intake thus fuelling the obesity pandemic.

Focusing on a high carbohydrate/low fat diet is a sensible option for Government to adopt as far as population targets are concerned. On an individual basis however, this may not be the correct approach. It is essential when dealing with individual obese patients, to ascertain their habitual dietary intake. High carbohydrate, low fat intakes can also lead to obesity and individual advice may vary from that aimed at populations. Indeed the heaviest patients often have a problem with control of carbohydrate intake rather than fat. There is therefore room to consider the position of low carbohydrate diets in the management of these individuals and taking an appropriate diet history is extremely important.

The role of very low calorie diets (VLCDs) also needs to be reviewed. In some patients this may be important in achieving and maintaining weight loss. In the early 1970s and 1980s, such diets received much adverse publicity due to their inappropriate constitution and consequent association with sudden death. Such problems arose out of inappropriate vitamin and trace metal content resulting in cardiac dysrhythmias and death. Newer VLCDs do not have such problems and can be used safely in appropriate individuals. Commercial meal replacement programmes are also appropriate in the management of obesity at least in the short term (Ditschuneit, 2006; Truby et al, 2006). More evidence is accumulating for their efficacy although major clinical trials are sadly lacking.

Low glycaemic index diets are also in vogue and certainly are associated with a reduced insulin response compared with that seen with high glycaemic index diets. The reduced insulin response and the flatter blood glycaemic curve seen after food intake reduce the post-prandial appetite stimulation seen with carbohydrates that produce rapid glycaemic responses. Again major clinical trials in this area are also lacking. The theoretical nature of this response is, however, appealing.

Behaviour therapy and associated stress management are also important in achieving long-term weight management. Cognitive behaviour therapy is the mainstay of behaviour change in association with motivational interviewing. It is also important to be aware of the patient's 'readiness to change' before approaching behaviour alteration to achieve weight reduction.

Drug therapy is an important adjunct to lifestyle change in the management of obesity. It must however not be used in isolation but always in combination with the above lifestyle measures. Currently only three drugs are in use and recommended in Europe:

Orlistat – a lipase inhibitor

Sibutramine – a satiety enhancer

Rimonabant – an appetite suppressant.

All of these drugs in their clinical trials produced similar amounts of weight loss over their two-year period of trial, i.e. 5–10 per cent weight loss, and were superior to lifestyle modification alone.

Orlistat effects a net negative energy balance by inhibiting fat digestion and absorption in the gut. Approximately 30 per cent of the fat ingested is not absorbed and hence appears in the faeces. This drug thus acts as an antabuse to fat in the diet and ensures patients maintain a reduced fat intake. Failure to do so produces major gastro-intestinal side effects that will not be tolerated by patients or their relatives and friends. Excess fat arriving in the large bowel is neutralised by gut bacteria producing foul-smelling and colonic irritating molecules resulting in explosive diarrhoea and excess flatus. This drug is therefore a useful adjunct where fat in the diet is the main contributor to obesity in that patient. If patients do not have a high fat intake and excess carbohydrate is the main contributing factor to the obese state, Orlistat will be ineffective. Orlistat itself is not absorbed from the gut and is removed in the faeces. There are therefore no long-term or systemic effects associated with the drug. Both Sibutramine and Rimonabant act centrally on the brain in different areas of the

hypothalamus. Sibutramine is a satiety enhancer through its mechanism as a serotonin reuptake antagonist. Serotonin is known to be involved in producing satiety signals in the hypothalamus. Sibutramine also acts peripherally as a noradrenaline reuptake inhibitor and can therefore by increasing heart rate lead to small increases in energy expenditure. There is also a risk of increasing blood pressure with this drug and careful monitoring is therefore necessary. Because of the effects on the sympathetic nervous system its use is contraindicated in patients with cardiovascular disease. As a result of possible drug interaction it is also contraindicated in patients receiving antidepressant therapy.

Rimonabant acts centrally in the hypothalamus by blocking the endocannabinoid pathway. The endocannabinoid system, when stimulated, increases appetite, and is known to have increased activity in the obese. Rimonabant blocks the cannabinoid-1 receptor (CB1) in the hypothalamus thus reducing appetite.

CB1 receptors are also present in other tissues, e.g. gut, adipose tissue, etc. By reducing the endocannabinoid tone peripherally rimonabant also has a beneficial effect on insulin resistivity and serum cholesterol levels and is thus useful in patients with metabolic syndrome or Type 2 diabetes mellitus. Again because of its central action, especially in blocking 'pleasure pathways' it can markedly adversely affect mood. It is therefore not recommended for use in patients with a history of mood disorder. The use of drug therapy is restricted to patients with BMI greater than 30 Kg/m² or patients with BMI greater than 28 Kg/m² and with one or more associated comorbidities.

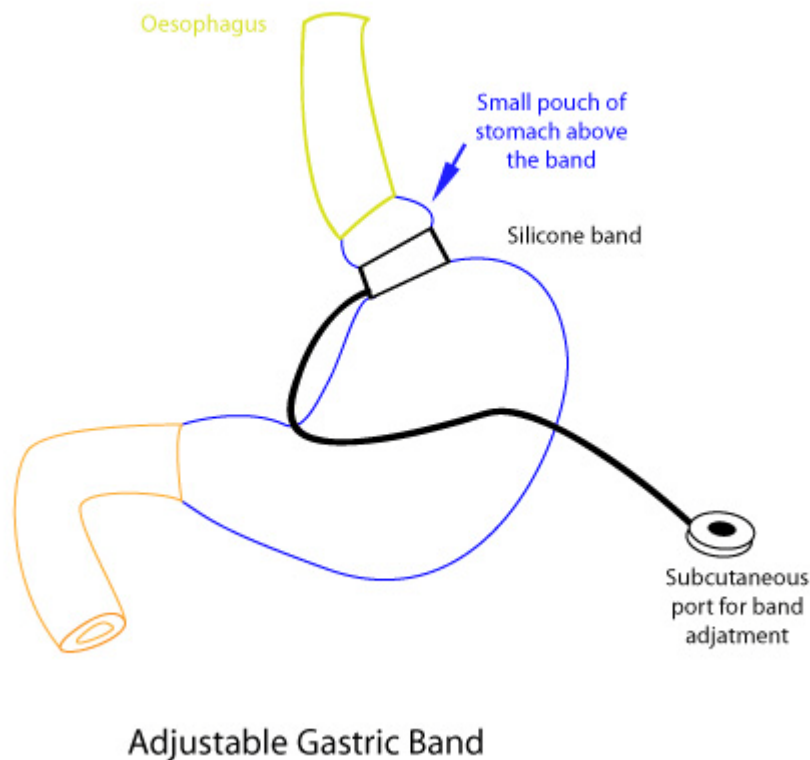
Surgery for obesity, bariatric surgery, has gained greater prominence over the years, as the obesity epidemic spreads. The development of minimally invasive techniques has also added to the increase in use of this approach to manage severe obesity. Indeed the primary treatment for patients with a BMI greater than 50 Kg/m² is now that of bariatric surgery as indicated in NICE [9] guidelines for the management of obesity.

Bariatric surgery has two main approaches:

- 1 A restrictive procedure
- 2 A restrictive plus malabsorptive procedure.

Restrictive procedures reduce the capability of the individual to take large amounts of food by physically reducing the size of the stomach. This can be achieved by one of two methods: laparoscopic banding (Figure 5.7) or a vertical banded gastroplasty .

Figure 5.7 Restrictive surgical procedure for managing obesity

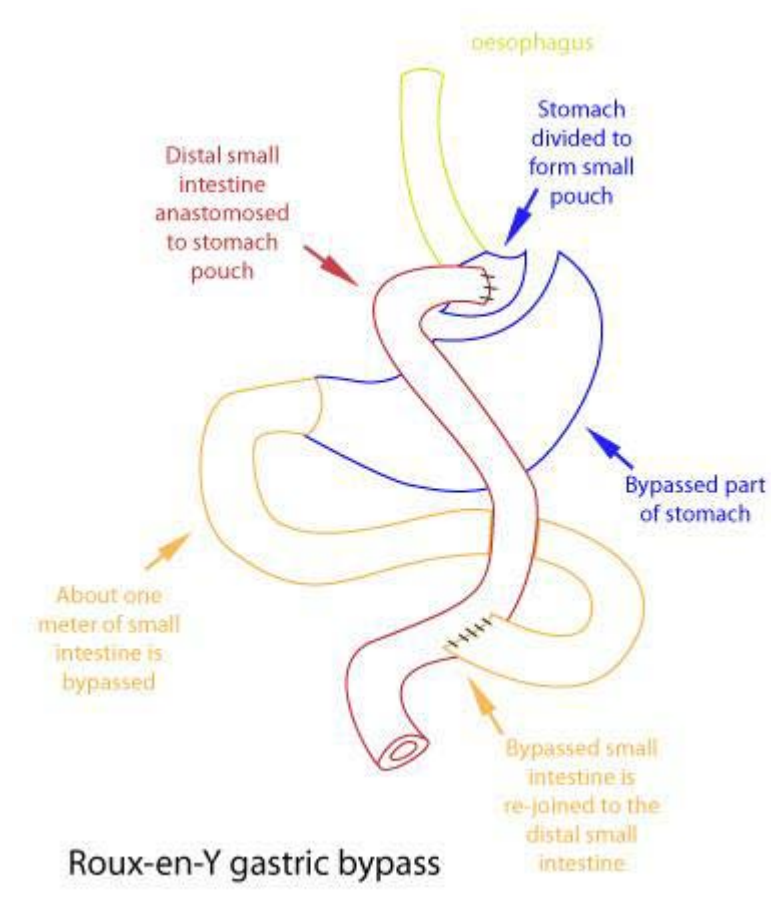


Both methods create a small gastric pouch with a narrow opening that restricts the emptying of solid food but allows normal emptying of liquids. Patients thus feel full after a relatively small meal and energy intake is thus drastically reduced. Both restrictive methods produce similar degrees of weight loss (~ 30 per cent of body weight in two years). Because of the lower complication rate associated with laparoscopic banding this has become the restrictive procedure of choice. This procedure involves the placement of an encircling inflatable band around the upper part of the stomach producing a small (15 ml) gastric pouch. Post-operatively the band is progressively tightened, by introducing small volumes of fluid via an injection port inserted subcutaneously, until the appropriate degree of restriction is achieved to allow suitable weight loss. Such procedures are used in patients where the BMI is $>35 \text{ Kg/m}^2$ with co-morbidities or where BMI is $> 40 \text{ Kg/m}^2$ without co-morbidities.

In patients where BMI is $> 50 \text{ Kg/m}^2$ restrictive/malabsorptive procedures are more often employed. Again a small gastric pouch is created but in addition a varying degree of small intestinal bypass is produced thus creating a malabsorptive process. The degree of bypass induced by surgery is somewhat dependent on the patient's BMI. A number of different types of malabsorptive procedures are used; the most widely performed being the Roux en Y gastric bypass (Figure 5.8).

Food entering the gastric pouch exits through a limb of small bowel joined side to side to the pouch. The remainder of the stomach and first part of the intestine is bypassed reducing absorptive capacity. There are other means of producing malabsorption of food using different surgical techniques, e.g. the biliopancreatic diversion and the duodenal switch, although these are not as commonly used as the Roux en Y procedure. Other treatments for the management of obesity include various herbal remedies and poorly constructed 'fad' diets. Neither of these have any evidence base on which to substantiate their claims. They are however frequently employed by the obese patient in an attempt to achieve and maintain weight loss. A great deal of commercial activity surrounds these claims with resultant considerable but ineffective expense by the patients.

Figure 5.8 Roux en Y gastric bypass



[A] Conclusion

Despite numerous statements by government and strategic attempts to achieve control of the population's weight, the obesity epidemic marches on. Because of the complex nature of the obesity epidemic, there is no easy solution to the problem. Environment changes and alterations in socio-economic factors will continue to impact on our genetic inheritance and homo sapiens will need to learn to adapt to these changes if homo adipatus is to be avoided. This will require major fundamental input from all aspects of government and not just the Department of Health. Failure to halt the obesity epidemic, especially as it is now affecting our children, will see a return of children dying before their parents, a situation not uncommon in the nineteenth century and before, but rare in the latter part of the twentieth century. Much greater

cooperation from the food industry, than hitherto has been seen, is required, as well as the cooperation of society as a whole, if the obesity epidemic is to be stopped and reversed.

[A]References

- [1] Thomas PR, ed. Weighing the Options. Criteria for Evaluating Weight-Management Programs. Washington, DC: National Academy Press; 1995.
- [2] Avenell, A., Broom, J., Brown, T.J., Poobalan, A., Aucott, L., Stearns, S.C., Smith, W.C.S., Jung, R.T., Campbell, M.K. and Grant, A.M. (2004). Systematic review of the long-term effects and economic consequences of treatments for obesity and implications for health improvement. Health Technology Assessment NHS R&D HTA Programme Vol. 8. No. 21.
- [3] Department of Health. (2006). *Forecasting Obesity to 2010*. London: Crown.
- [4] The Counterweight Project Team (2004). Current approaches to obesity management in UK primary care: the Counterweight Programme. *Journal of Human Nutrition and Dietetics* 17: 183--90.
- [5] The Counterweight Project Team (2004). A new evidence-based model for weight management in primary care: the Counterweight Programme. *Journal of Human Nutrition and Dietetics* 17: 191--208.
- [6] The Counterweight Project Team (2005). Empowering primary care to tackle the obesity epidemic: The Counterweight Programme. *European Journal of Clinical Nutrition* 59: Suppl. 1, S93--101.
- [7] The Counterweight Project Team (2005). Obesity impacts on general practice appointments. *Obesity Research* 13 (8): 1442--9.

[8] The Counterweight Project Team (In press). Exploring the experiences and views of weight management from practice staff involved in the Counterweight programme.

Family Practice.

[9] NICE guidelines (2007).

<http://www.nice.org.uk/search/guidancesearchresults.jsp?keywords=obesity&searchType=guidance> (last accessed 19 January 2009).

Scottish Executive (2006). *Health in Scotland 2005. Chapter 7: Obesity*. Edinburgh: Crown.

The Economist Newspaper (2003). The World's expanding waistline. The shape of things to come. December 11th.

Flatt, J.P. 1985, "Energetics of intermediary metabolism" in *Substrate and Energy Metabolism*, eds. J.S. Garrow & D. Halliday, J Libbey, London, pp. 58-69.

Lean, M.J. & James, W. P. T. 1986, "Prescription of diabetic diets in the 1980s.", *Lancet*, vol. 1, pp. 723-725.

Lean, M.J., James, W. P. T. & Garthwaite, P.H. 1989, "Obesity without overeating? " in *Obesity in Europe 88*, eds. P. Bjorntrop & S. Rössner, J Libbey, London, pp. 281-286.

Lean, M.E. & James, W.P. 1988, "Metabolic effects of isoenergetic nutrient exchange over 24 hours in relation to obesity in women", *International journal of obesity*, vol. 12, pp. 15-27.

Caterson, I.D. & Broom, J. (eds) 2001, *Pocket Picture Guide Obesity*, Harcourt Health Communications.

Ditschuneit, H.H. 2006, "Do meal replacement drinks have a role in diabetes management?", *Nestle Nutrition workshop series. Clinical & performance programme*, vol. 11, pp. 171-9; discussion 179-81.

Truby, H., Baic, S., deLooy, A., Fox, K.R., Livingstone, M.B., Logan, C.M., Macdonald, I.A., Morgan, L.M., Taylor, M.A. & Millward, D.J. 2006, "Randomised controlled trial of four commercial weight loss programmes in the UK: initial findings from the BBC "diet trials"", *BMJ (Clinical research ed.)*, vol. 332, pp. 1309-1314.